

299-W18-185 (A7667) Log Data Report

Borehole Information:

Borehole: 299-W18-185 (A7667)		Site: 216-Z-12 Crib			
Coordinates (WA St Plane)		GWL¹ (ft): None		GWL Date: 01/05/06	
North (m)	East (m)	Drill Date	TOC Elevation	Total Depth (ft)	Type
135458.666	566367.254	05/80	687.34	40.0	Cable

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Steel	2.7	6 5/8	6 1/16	9/32	2.7	40

Borehole Notes:

The logging engineer measured the casing stick-up and diameter using a caliper and steel tape. Logging data acquisition is referenced to the TOC. Grout is emplaced around the casing to 16 ft and is used as a plug at the bottom of the borehole from 40 to 41 ft.

Logging Equipment Information:

Logging System: Gamma 1E		Type: SGLS (70%) SN: 34TP0587A	
Effective Calibration Date:	01/10/06	Calibration Reference: DOE-EM/GJ1106-2006	
		Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3 Repeat	4 Repeat	
Date	02/13/06	02/14/06	02/14/06	02/17/06	
Logging Engineer	Spatz	Spatz	Spatz	Spatz	
Start Depth (ft)	16.0	38.0	28.0	27.5	
Finish Depth (ft)	13.0	15.0	26.5	17.5	
Count Time (sec)	100	100	400	400	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
ft/min	N/A ²	N/A	N/A	N/A	
Pre-Verification	AE160CAB	AE162CAB	AE162CAB	AE163CAB	
Start File	AE161000	AE162000	AE162024	AE163000	
Finish File	AE161013	AE162023	AE162027	AE163020	
Post-Verification	AE161CAA	AE162CAA	AE162CAA	AE163CAA	

Log Run	1	2	3 Repeat	4 Repeat	
Depth Return Error (in.)	0	N/A	N/A	0	
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.	

Logging Operation Notes:

Logging was conducted with a centralizer on the sonde and measurements are referenced to top of casing. Repeat data were acquired at 400 second counting time at 0.5 ft intervals to provide additional detail of the highest activity zone.

Analysis Notes:

Analyst:	Henwood	Date:	07/24/06	Reference:	GJO-HGLP 1.6.3, Rev. 0
-----------------	---------	--------------	----------	-------------------	------------------------

Pre-run and post-run verifications for the SGLS were performed before and after each day's data acquisition. The acceptance criteria were met.

A casing correction for 9/32-in.-thick casing was applied throughout the borehole.

SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with an EXCEL worksheet template identified as G1EJan06.xls using an efficiency function and corrections for casing and dead time as determined from annual calibrations.

Results and Interpretations:

^{241}Am is detected between 20 and 27 ft. The maximum concentration is measured at approximately 1 million pCi/g at 22 ft. A comparison plot shows detected gamma rays at 662 and 722 keV that may represent ^{241}Am . It is apparent that more than one radionuclide is represented in the approximate 662 energy peak. For example, ^{137}Cs emits a 661.62 gamma ray that cannot be distinguished from the 662.40 gamma ray emitted from ^{241}Am . A corroborating energy peak at 722.01 keV is used to establish the presence of ^{241}Am rather than ^{137}Cs . In this borehole the 722.01 keV energy peak is used to determine the ^{241}Am concentration. Also note the 208.01 keV energy peak is elevated relative to the 619.01 and 722.01 keV energy peaks, suggesting an interfering gamma ray at this energy.

^{239}Pu is detected between 22.5 and 26.5 ft. The maximum concentration is measured at approximately 1.5 million pCi/g at a 22.5 ft depth. An evaluation of ^{239}Pu energy peaks determined the 375.05 energy peak had no significant interferences and is used to calculate concentrations.

As mentioned above, there appear to be interfering gamma rays at an energy of approximately 208 keV. These gamma rays are likely the 208.01 keV ^{241}Am and 208.00 ^{237}U gamma rays. ^{237}U is a decay product of ^{241}Pu , which is in equilibrium with its parent, so that an assay of ^{237}U represents the activity of ^{241}Pu . After subtracting the influence of the 208.01 keV gamma line emitted by ^{241}Am (based on the 722.01 keV energy peak) from the total counts in the 208 keV energy peak, a maximum activity of 25 pCi/g is estimated for ^{241}Pu .

Weapons grade plutonium is generally considered to be in approximate proportions of 94% ^{239}Pu , 6% ^{240}Pu , and 0.005% ^{241}Pu . Using these proportions, ^{240}Pu could be expected to be on the order of 90,000 pCi/g and ^{241}Pu at 75 pCi/g. The reason for the difference in ^{241}Pu estimates is, in part, attributed to decay of ^{241}Pu (half life of approximately 14 years) since it was deposited in the crib.

^{237}Np is detected with the SGLS by measuring a daughter product (protactinium-233 (^{233}Pa)) that emits a prominent gamma ray at an energy of 312.17 keV. ^{233}Pa was detected between 20 and 31 ft. The maximum concentration is approximately 60 pCi/g at a 25 ft depth.

A slightly elevated ^{232}Th concentration, as determined using the 2615 keV (^{208}Tl) energy peak, is indicated between 20 and 28 ft. The plot of natural gamma logs shows the disruption of the equilibrium of the natural ^{232}Th decay, where between 20 and 28 ft the ^{228}Ac indicates ^{232}Th concentrations below that calculated from the 2615 keV gamma line. This difference is attributed to the existence of ^{232}U which shares the same decay chain as ^{232}Th , beginning at ^{228}Th . ^{228}Th is the first daughter of ^{232}U and the third daughter of ^{232}Th ; ^{228}Ac is the second daughter of ^{232}Th . To determine the concentration of ^{232}U , the activity due to natural decay of ^{232}Th , must be subtracted. The ^{228}Ac concentration is subtracted from the ^{232}Th concentration calculated based on the 2615 keV ^{208}Tl energy peak. The result is a maximum concentration of approximately 1.5 pCi/g ^{232}U . For the naturally occurring ^{232}Th , the 2615 keV peak is used to calculate concentrations except for the interval from 20 to 28 ft where ^{228}Ac is used.

^{233}U almost certainly exists where ^{232}U is detected. In a reactor using thorium target material, ^{233}U will be generated at roughly three orders of magnitude more than ^{232}U . However, at relatively low concentrations, ^{233}U does not emit a gamma ray that can be detected with the SGLS. Decay products that potentially could be measured, have not had sufficient time to grow into equilibrium with their parent so that detection is possible. It is inferred on the basis of the ^{232}U concentration that less than 300 pCi/g ^{233}U may exist in this waste stream.

A passive neutron log was not run in this borehole. However, high concentrations of transuranic radionuclides imply high levels of alpha activity in the formation. Although alpha particles are blocked by the steel casing, secondary phenomena associated with alpha interactions result in neutrons and gamma rays, which can be detected. For example, the gamma ray at 2223 keV is emitted with neutron capture by hydrogen. Few credible decay gamma rays occur at this energy level, and the detection of this peak in a passive gamma energy spectrum suggests both a significant neutron flux and the presence of hydrogen. Neutrons are generated by alpha capture reactions in light elements, such as oxygen, nitrogen, or fluorine. Gamma activity detected at 1274 keV may originate from ^{22}Na (HL - 2.6 y), which is produced from alpha capture by ^{19}F . Additional prompt gamma rays at 1274 and 583 keV are emitted with alpha capture by fluorine. ^{19}F is the dominant fluorine isotope and it has a much higher capture cross section for alpha particles in the 5 MeV range, compared to oxygen or nitrogen. The presence of gamma rays associated with alpha capture by fluorine is strong evidence that the plutonium is present as a fluoride compound, at least to some degree. Other secondary gamma rays, indicative of neutron activity, are also detected. These include gamma rays at 847 and 1811 keV, which are attributed to neutron activation of ^{55}Mn .

Spectral gamma data were acquired in this borehole in 1993 and 1998 by Westinghouse Hanford Company and Waste Management Federal Services NW, respectively, using the Radionuclide Logging System (RLS). A comparison plot of the RLS (1993 and 1998) and SGLS (2006) manmade radionuclides show similar concentrations for ^{233}Pa and ^{239}Pu . However, ^{241}Am concentrations are significantly different. It is suspected the RLS analysis utilized a different energy peak (such as the 60 keV energy peak) to determine ^{241}Am concentrations than the current analysis, which used the 722.01 keV energy peak. The low energy peak at 60 keV is out of the SGLS calibration range, as it is severely attenuated by the steel casing.

The RLS analysis identified a "thorium disequilibrium" condition. Current analysis suggests this disequilibrium is an indication of ^{232}U .

The RLS analysis appears to have attributed all of the counts in the 662 keV peak to ^{137}Cs . The current analysis has identified approximately 11 of a total 477 counts in the highest 662 energy peak to be from ^{241}Am . Consequently, subtracting the ^{241}Am influence from the 662 keV peak, only causes the ^{137}Cs assay to be approximately 5 pCi/g less. The comparison of the ^{137}Cs profiles from 1993 to 2006 suggests no significant change. However, the ^{137}Cs concentrations should have decreased by 15 to 20 percent due to decay. The apparent lack of decay suggests the 662 keV energy peak may have contributions from other radionuclides. It is also postulated that small amounts of fission products may be produced in situ by fissioning of ^{239}Pu in the intense neutron flux.

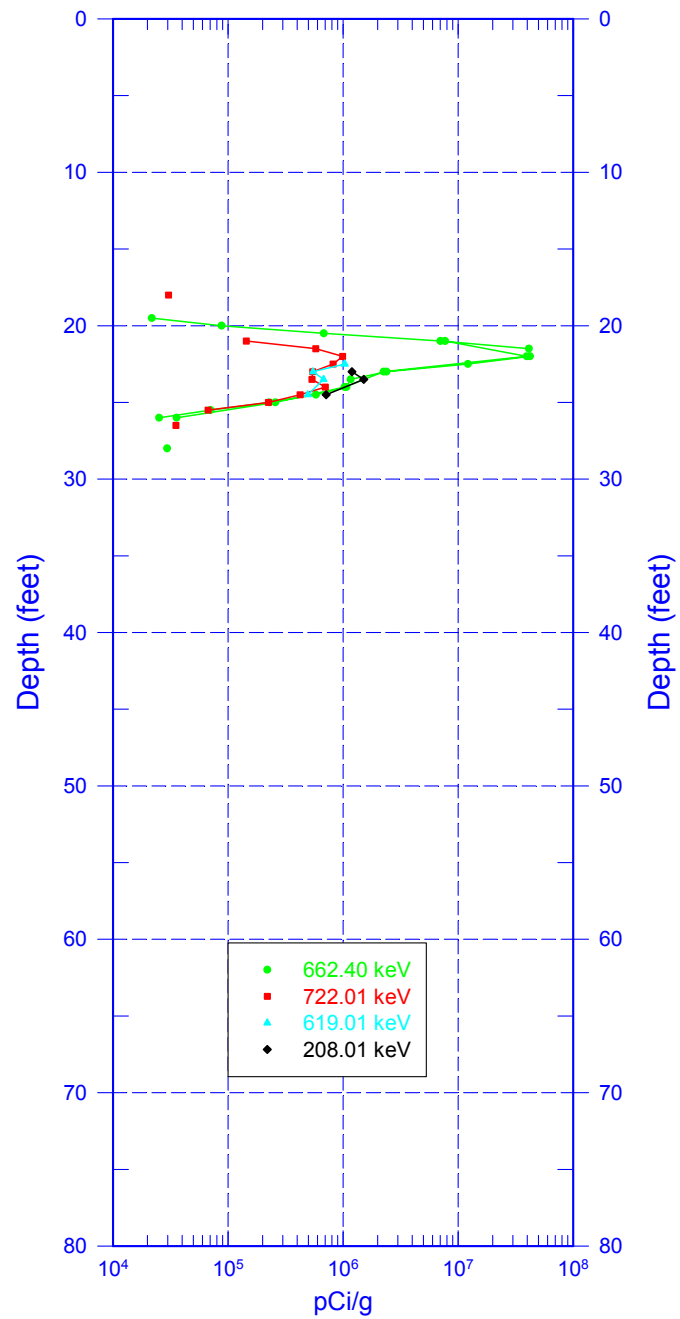
List of Log Plots:

²⁴¹Am Energy Peak Comparison
Man-Made Radionuclides
Natural Gamma Logs
Combination Plot
Total Gamma & Dead Time
SGLS/ RLS Comparison Plot
Repeat Section for Manmade
Repeat Section for Natural Gamma Logs

¹ GWL – groundwater level

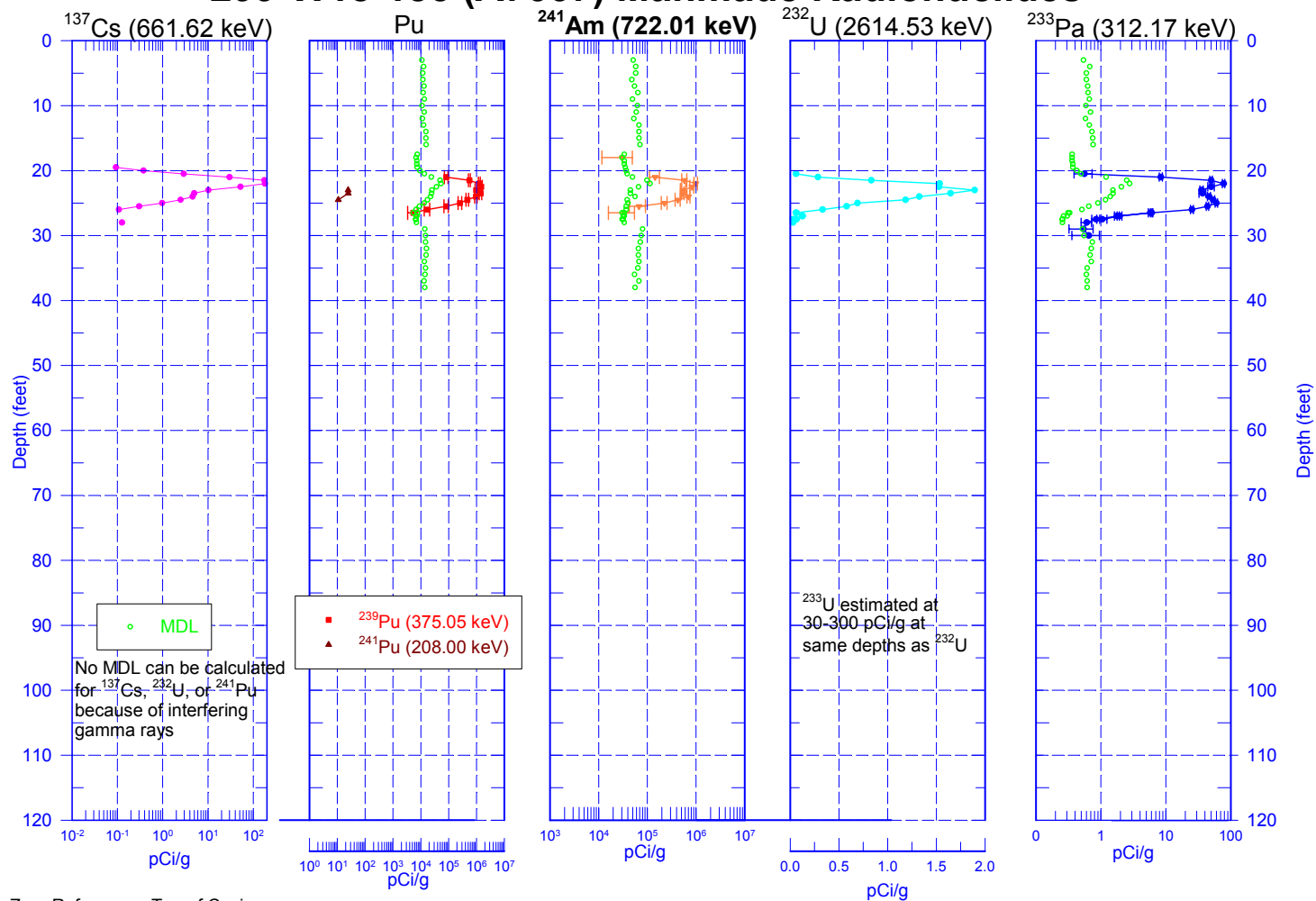
² N/A – not applicable

299-W18-185 (A7667) ²⁴¹Am Energy Peak Comparison

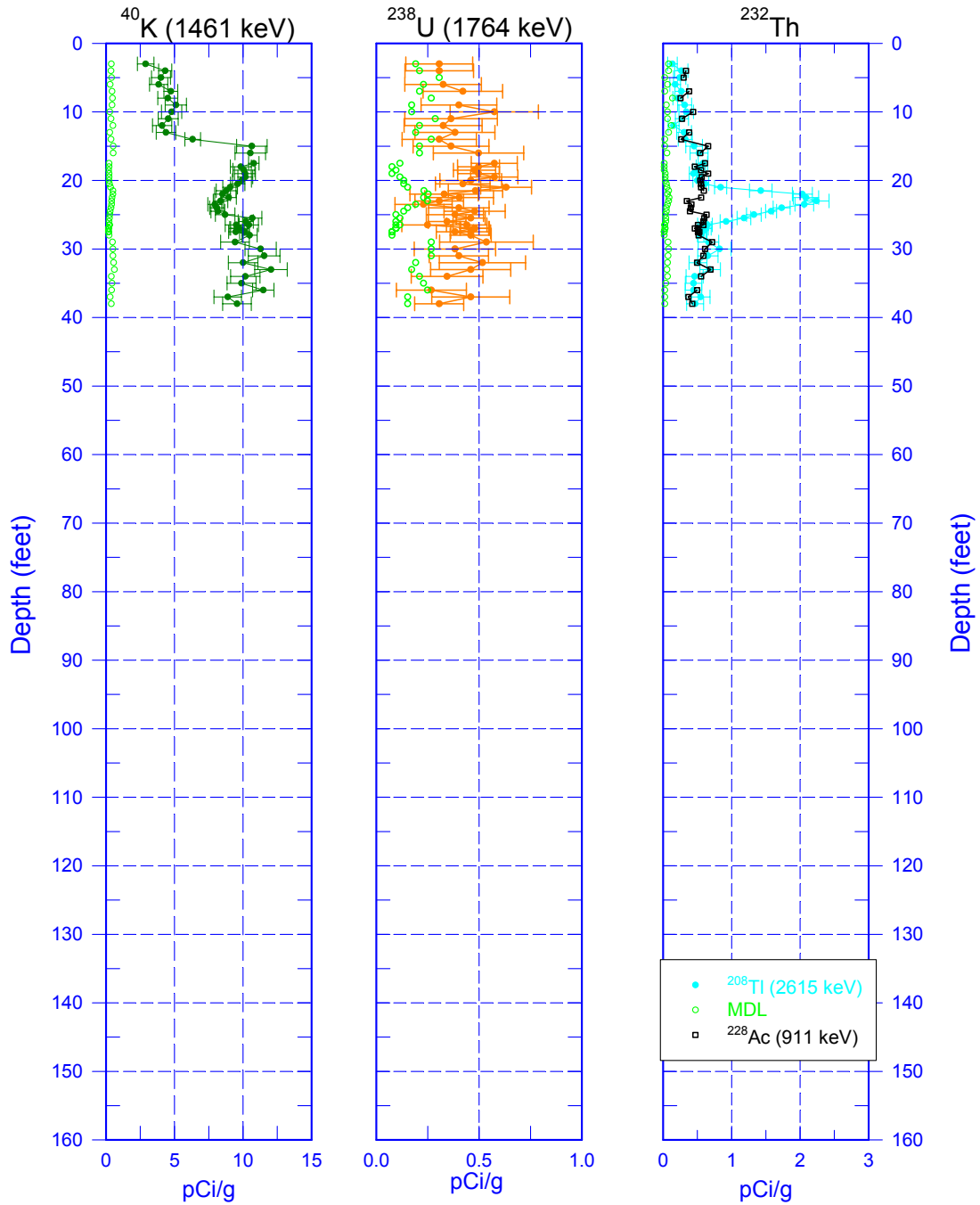


Zero Reference - Top of Casing

299-W18-185 (A7667) Manmade Radionuclides

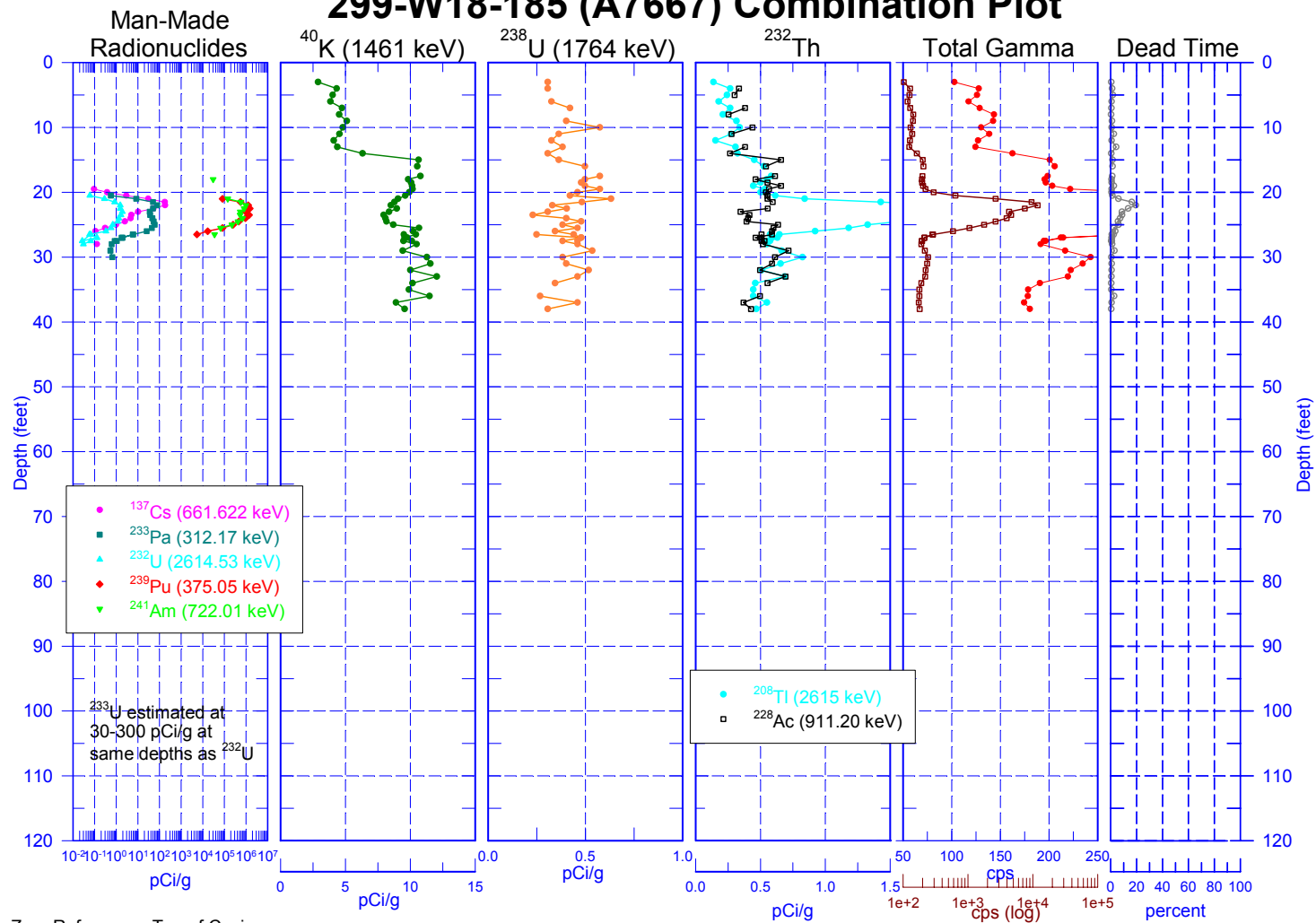


299-W18-185 (A7667) Natural Gamma Logs

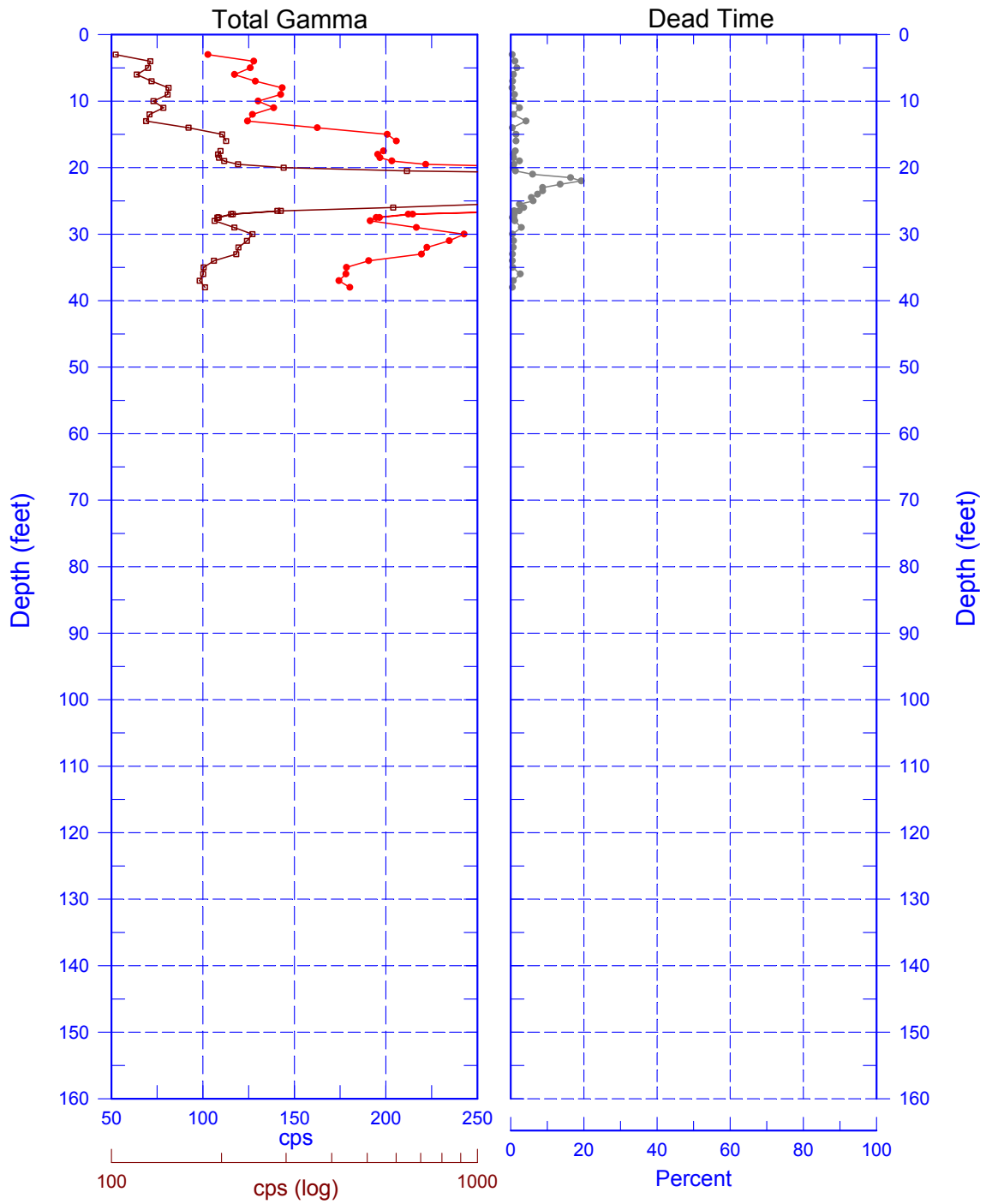


Zero Reference = Top of Casing

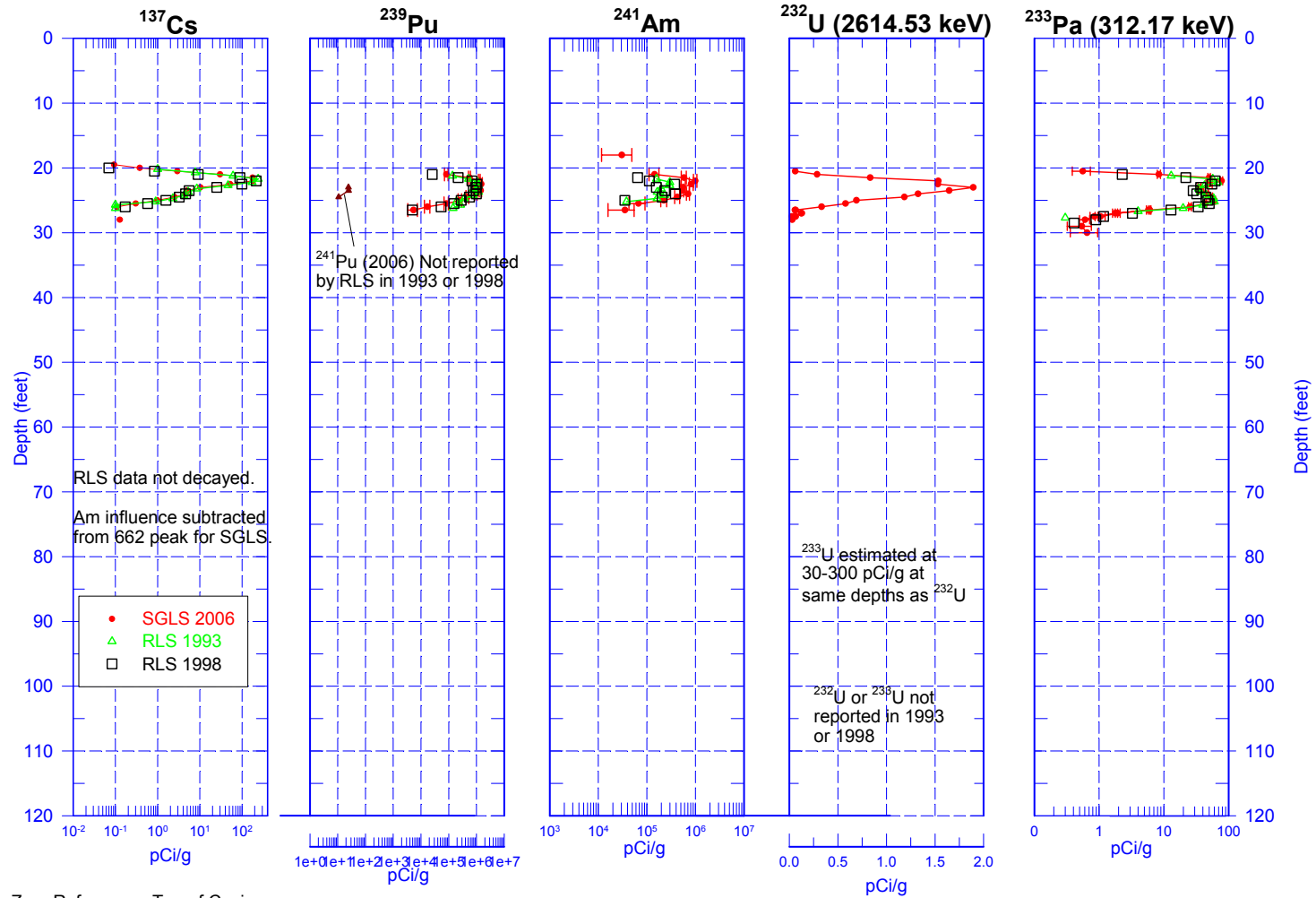
299-W18-185 (A7667) Combination Plot



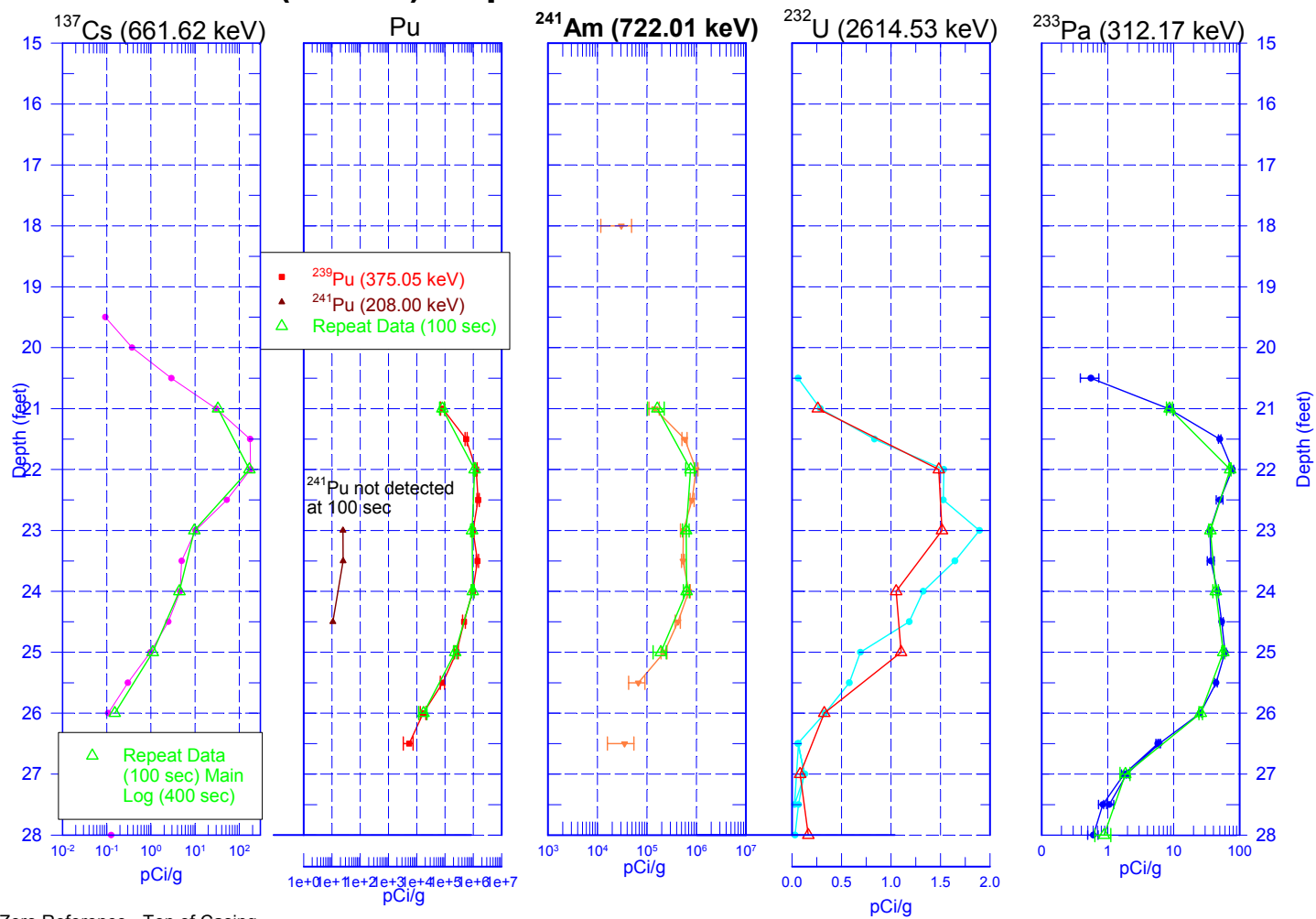
299-W18-185 (A7667) Total Gamma & Dead Time



299-W18-185 (A7667) SGLS/RLS Comparison Plot

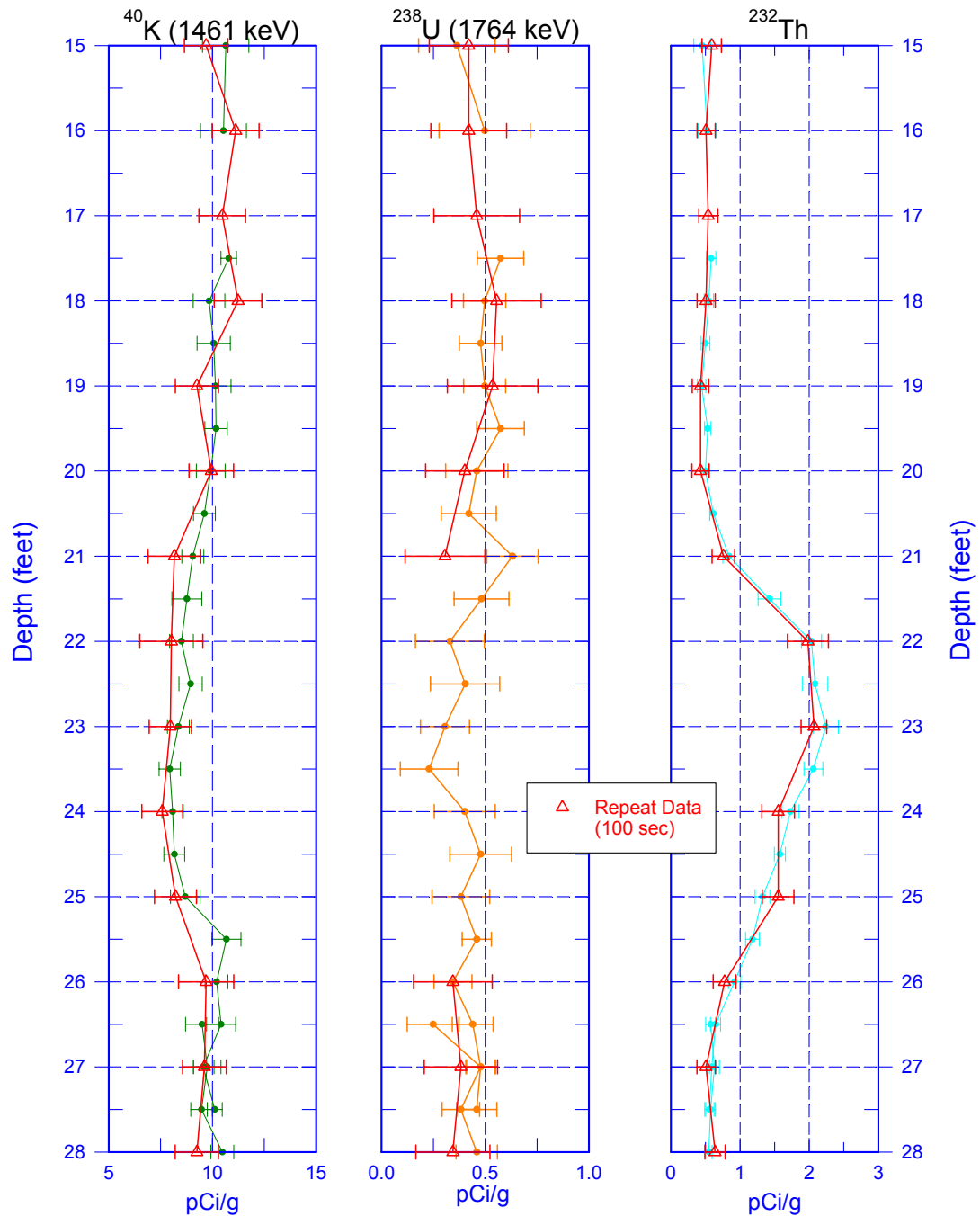


299-W18-185 (A7667) Repeat Section for Manmade Radionuclides



Zero Reference - Top of Casing

299-W18-185 (A7667) **Repeat Section for Natural Gamma Logs**



Zero Reference = Top of Casing